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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--|-------------|----------------------|--------------------------|------------------|
| 09/243,433 | 02/08/2002 | YUNG-TSUN LO | REF/LO535CIP | 2498 |
| 7590 04/21/2004 BACON & THOMAS 625 SLATERS LANE 4TH FLOOR ALEXANDRIA, VA 223141176 | | | EXAMINER NGUYEN, HA T | |
| | | | ART UNIT 2812 | PAPER NUMBER |

DATE MAILED: 04/21/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Applicati n No.

09/243,433

Applicant(s)

LO ET AL.

Examiner

Ha T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 25 February 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-12 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-12 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Notice to applicant

1. Applicant's Amendment and Response to the Office Action mailed 12-4-3 has been entered and made of record .

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over applicants' admitted prior art (hereinafter "APA") in view of Kinoshita et al. (USPN 5332691, hereinafter "Kinoshita") and Foster et al. (USPN 5273588, hereinafter "Foster").

[Claim 1] APA discloses a process for manufacturing by CVD a W-plug in a semiconductor device which comprises depositing a SiO₂ insulation layer on top of a substrate by CVD, then depositing a layer of BPSG onto the SiO₂ layer for surface planarization by employing CVD again; partially etching the SiO₂ layer and the BPSG layer to form a contact hole to the substrate; performing ion implantation through the contact hole and forming the device in the substrate; sputter depositing a barrier metal layer comprising a Ti and TiN bilayer in which the Ti metal is underneath the TiN in the Ti/TiN bilayer; depositing W nucleation layer and W bulk metal using a quartz clamp ring to control the area; forming the W-plug in the contact hole by a plasma anisotropic etch back procedure (See back ground section). But it does not disclose expressly the use of two CVD chambers with different clamp rings; sputtering an Al/Si/Cu layer and patterning metal line. However, the missing limitation is well known in the art because Kinoshita discloses the use of two different CVD chambers to deposit W, sputtering an interconnect layer 9 and patterning the interconnect layer (See Fig. 1D and col. 5, lines 9-15, line 51-col. 6, line 10); and Foster discloses the use of different clamp rings to fit the desired

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surface for deposition (see col. 18, lines 37-56). The combined teaching of APA, Kinoshita, and Foster does not disclose Al/Si/Cu interconnect. However, the examiner takes Official Notice that Al/Si/Cu is the most common interconnect material used in the art. A person of ordinary skill is motivated to modify APA with Kinoshita and Foster to obtain fabrication process flexibility and easy control.

[Claim 6] The combined teaching of APA, Kinoshita and Foster discloses substantially the limitations of claim 6, as shown above. Kinoshita also discloses the use of WF_6 and SiH_4 and WF_6 and H_2 to deposit layers of W (see col. 4, lines 25-54).

[Claims 2-4 and 7-9] The combined teaching of APA, Kinoshita, and Foster discloses substantially the limitations of claims 2-4, as shown above. But it does not disclose the width of the different rings for depositing Ti/TiN, W nucleation, W bulk layers. However any variation in width of the rings in the present claims is obvious in light of the cited art, because the changes in ring width produce no unexpected function.

The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406.

[Claims 5 and 10] Kinoshita also discloses a W nucleation in the range of 250 to 500 Å (see col. 4, lines 11-22 and col. 5, lines 35-50).

Therefore, it would have been obvious to combine APA with Kinoshita and Foster to obtain the invention as specified in claims 1-10.

4. Claims 11 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Kinoshita and Foster, as applied above, and further in view of Merchant et al. (USPN 5489552, hereinafter "Merchant").

The combined teaching of APA, Kinoshita and Foster discloses substantially the limitations of claims 11 and 12, as shown above.

But it does not disclose expressly the formation of TiN by rapid thermal nitridation and the conditions used.

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However, the missing limitations are well known in the art because Merchant discloses these features (See col. 3, lines 25-52).

A person of ordinary skill is motivated to modify APA , Kinoshita and Foster with Merchant to obtain TiN in a suitable manner.

Therefore, it would have been obvious to combine APA , Kinoshita and Foster with Merchant to obtain the invention as specified in claims 11 and 12.

Response to Amendment

5. In view of Applicant' s amendment to the claims, the objection to claims 1-10, for informality, has been withdrawn.

Applicant' s arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicant argued that Foster et al. (USPN 5273588, hereinafter "Foster") uses rings of different sizes to accommodate wafer sizes not to control the area and thickness of the deposited layers. This is true however whether it is for the right size of wafers or the right areas for deposition, there is not much difference, since in both situation the use of different ring sizes is to obtain the desired area for deposition whether it is on a single wafer or different wafers. It would have been obvious for a person of ordinary skill in the art to use different ring sizes to obtain the appropriate area. Novelty occurs only when the use of two different ring sizes brings about an unexpected result. This is not the case.

Applicant' also argued that Merchant et al. (USPN 5489552, hereinafter "Merchant") does not teach rapid thermal nitridation as claimed. The examiner disagreed, broadly interpreted Merchant does disclose a rapid thermal nitridation because TiN is obtained when heating Ti in the presence of nitrogen whether the nitrogen is from the environment or attached to the sputtered Ti particles.

Therefore APA in view of the applied references does teach or make obvious the limitations of all the rejected claims.

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Conclusion

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for response to this final action is set to expire THREE MONTHS from the date of this action. In the event a first response is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event will the statutory period for response expire later than SIX MONTHS from the date of this final action.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha Nguyen whose telephone number is (571) 272-1678. The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Neibling, can be reached on (571) 272-1679. The fax phone number for this Group is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.



Ha Nguyen

Primary Examiner

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